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Flight test in Patuxent River is making positive and dramatic moves to incorporate the team concept into all flight test programs. "Up front and early" has replaced "kick it over the fence" as the basic flight test philosophy. In a world where tradeoffs between cost, schedule, and performance drive the entire acquisition process, the team concept is gaining strength. The product continues to be better and better as potential problems are averted on many programs earlier and earlier. Early problem identification and resolution are saving millions of dollars, and are enabling a much higher mission performance and safer aircraft for the flight test program and the end fleet user.

There are still many challenges ahead. Teaming is an evolutionary concept whose time has come, but the evolution is not complete. A few more years are required to institutionalize the changes developed over the last decade. While the fleet continues to press crew concept, CRM/ACT, and teaming throughout the various communities, teaming has certainly found a home in Navy flight test and indeed the entire acquisition community. With continued reductions I programmatic cost and schedule, and increases in system safety and performance that teaming brings to the table, it is definitely here to stay.

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Evolution of the Teaming Concept In Naval Aviation Flight Test

In Naval Aviation flight test of the 1940's and 50's, test pilots were selected almost exclusively from the fighter and attack communities. Then, as now, the test pilot was a fleet aviator first and a test pilot second. Tour lengths were fairly short, 2 to 3 years, then the pilots went back to the fleet to keep up with the changes taking place on the "front lines." As in any organization, flight test took on the flavor of its pilots, in this case, single seat and dependent upon themselves for survival. These fighter pilots tested all aircraft destined for use in Naval Aviation from the F-4U Corsair to the P-2V Neptune.

The Naval Air Test Center was divided into several Test Directorates, including Flight Test and Systems Test. The test pilots were trained to perform either flight test or systems test, rarely both. The plane was thought of separately from the systems it used to do its mission. The Flight Test Directorate tested whatever aircraft industry produced. Test pilots traveled to the contractor's facility to learn about the new planes they were about to get, rarely to influence the designs or system integration. The test pilot and flight test engineers received their ships from industry, and worked for months, even years, identifying deficiencies that they found on "finished products" during what was called the "developmental phase" of flight test. These deficiencies were fed back to the designers, changes were made to accommodate or fix these problems, and the plane was sent back for more flight test. We called this "kicking it over the fence." The designers and builders would throw it over the fence to the testers, who would test it and throw it back to fix the problems that they found. The process continued until the aircraft was "acceptable" for the fleet, as determined by the test pilots that flew them, or it was cancelled.

Planes were much less sophisticated and cheaper (even given inflation) to build in those days, and we changed Type/Model/Series (TMS) in fleet squadrons several times per decade. Accident rates were much higher then too, averaging 50-60 aircraft lost per 100,000 flight-hours. Mishaps were viewed as a part of flying. As technology advanced and planes became more and more sophisticated in design, changes discovered in developmental flight test phases became more and more expensive to correct. Some problems were not fixed because they were too expensive to implement in the production line and retrofit throughout the fleet. These deficiencies were typically corrected in the next production version of the plane, or the next plane designed and built by that company. Deficiencies not fixed often generated changes in procedures that "worked around" the deficiency.

There are many planes flying in the fleet today that have basic design or functionality deficiencies, limiting the operational capabilities or creating human factors problems that relate directly to flight safety. While the test pilots are trained to qualitatively determine the potential impact of deficiencies, it is extremely difficult to quantify the potential down line risk to plane and pilot, or estimate the total cost of leaving deficiencies in the planes. How do you quantify losses because of having the pilots "workaround" these problems while attempting other high gain tasks such as air-to-air combat, weapons deliveries, or executing emergency procedures? How do you

quantify just how many planes will be (or were) lost due to "pilot error" because deficiencies were left in planes and operational workarounds were developed instead? While these were difficult to impossible tasks to quantify, the ever rising cost of correcting deficiencies was not.

As time progressed, engineers began to realize that one of the ways to reduce the cost to fix these deficiencies was to try and catch them earlier, perhaps as early as the design phase. This led to the creation of a Preliminary Design Review (PDR) and a Critical Design Review (CDR) process where teams could influence the design process very early on, many times long before metal was bent and the plane or system was still on paper. (This concept was very successful from a manager's view point, and on some programs was expanded to include Quarterly Design Reviews and Technical Interface Meetings (TIM's).) For years, it was rare for a test pilot and/or test engineer to be included in these meetings, which were usually covered by program office personnel. Officers from each community with an engineering background, known as "Class Desks," were responsible to the program office for the engineering influence on all developmental aircraft and systems. Even if test pilots and engineers were invited to these events, rarely could they go because of the workload of existing products lined up for test. Sometimes nontest, pilot-trained fleet aviators were used to get direct inputs on new systems and design issues. This lack of participation led to us not being "invited" to attend and helped create an isolationist mentality between flight test and the program office.

This isolationist attitude became almost the norm in test pilots and engineers, and we became "those test guys." While we did great work for the fleet and the program office, we were often blamed for delays caused by system short comings, because they were discovered during test. The test community began to get a reputation in the program offices for being a stumbling block or hurdle to be jumped rather than a valuable member of the team, striving to get quality products into the hands of the fleet user. Testing that the program office saw no need for became known as "science projects." As this rift grew, the test community became more standoff-ish. The Test Pilot School (TPS) taught us to be "above the team." We began to use words like "within the scope of these tests" in reports. To the program office, this translated to "any other problems that you may find while using this product were not discovered because those cheap skates at the program office didn't fund us to test everything!" It was also drilled into us that we could never recommend a fix to the deficiency, no matter how obvious, because the program office (and the contractor) might hold us liable if the fix didn't work or was incorrectly implemented. The tighter money became, the more the program office put pressure on the test community to "stop testing and just get it out the door."

As we moved through the 1960's and 70's into the 80's, aircraft cost per unit soared and new model production slowed dramatically. Aircraft TMS stayed in squadrons longer. Test pilots began coming from their own fleet communities. They brought with them the specific mission interests of their community. They tested the aircraft and systems that were needed to carry out their missions. The Test Directorates reorganized into "like platform" organizations. Strike Aircraft Test Directorate picked up

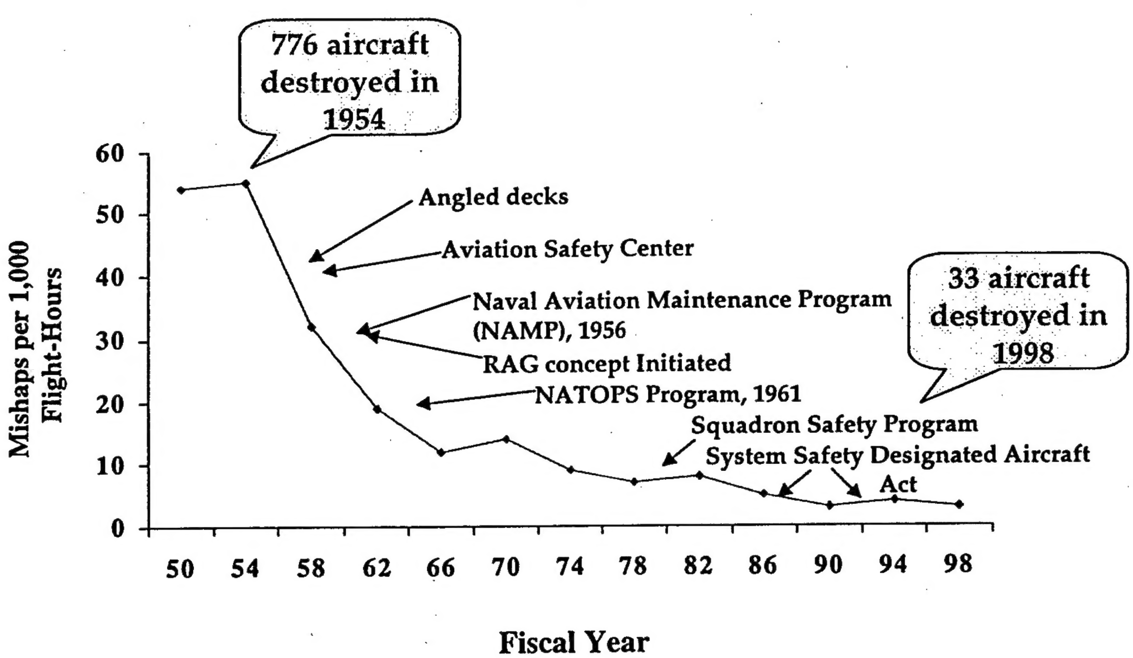
all the fighter and attack platforms, Force Aircraft Test Directorate (then ASW Test Directorate) picked up the large aircraft, and Rotary Wing Aircraft Test Directorate all the helicopter types. TPS went to a fixed-wing pilot curriculum, a rotary-wing pilot curriculum, and a systems curriculum. All pilots were trained as fixed- or rotary-wing test pilots, with a healthy dose of systems test knowledge thrown in. The engineers and Naval Flight Officers (NFO's) were trained in the systems curriculum. As before, the test directorates took on the flavor of the communities that the test pilots came from.

In the fleet, changes were occurring too....

As the fighter and attack communities developed and institutionalized their single-seat mentality, large fleet aircraft communities (such as the Airborne Early Warning and Patrol) and helicopter communities were developing crew concepts. Dollar cost of mishaps was adding up fast, and flight safety began driving significant changes in Naval Aviation communities. Angled flight decks were in, straight decks were out. We stood up the Naval Safety Center, and the Naval Aviation Training and Operational Procedures Standardization programs began in the 60's. The new Safety Center analyzed mishaps and made recommendations to the communities. Accident rates began to drop dramatically across the fleet.

Naval Aviation Mishap Rate

FY 50 - 98



In large aircraft mishaps, where the crews survived, interviews showed that many were caused by the breakdown of crew communications during emergency situations. The guy with the right answer was not in the information/decision loop, and uninformed or bad decisions were made. In an effort to improve this, a Crew Resource Management (CRM) program was started in the early 1980's. CRM trained crews to work better together, through the proper use of teaming techniques. These techniques by no means relieve the aircraft commanders or mission commanders of their responsibilities as the officer in charge, but allow an avenue for the "other guys" to voice their concerns and present possible solutions. This shift was slow to be accepted in the fighter/attack communities, because they "don't have a crew." However, the decline in mishaps was hard to refute especially in the helo communities. Over several years, CRM became known as Aircrew Coordination Training (ACT) and it is now spreading to all of Naval Aviation and into the USAF. Each TMS in the Navy now has its own aircraft specific ACT program. As a direct result of this and other programs, 1999 is proving to be the safest year ever on record in Naval Aviation.

....Meanwhile, back in flight test....

Because the test directorates were now a microcosm of their fleet communities, no where was this crew philosophy change more obvious than the large aircraft test community where crews and CRM were already the norm. Their planes were all multicrewed, and the pilots were accustomed to everyone doing their job and being "an equal" member of the crew/team from a mission perspective. The test flightcrew naturally became a team as well, including not just the test pilot and flight test engineer, but the "back end" operators, the technicians, and the maintenance crews that supported them. The test pilot and/or test NFO assigned began to act as a "project officer," not only working programmatic issues within the team but developing, managing, and flying the flight tests for the project as well. All members of the team had their say on issues ranging from the conduct of the test, to the data collected, and the test techniques used to collect it. More and more, the test pilots worked as a team with the program office, attending PDR and CDR and various Technical Interchange Meetings (TIM's.) More and more, the teams worked directly with industry to develop aircraft and systems. Gradually, "up front and early" became the norm, rather than "kick it over the fence."

In the early 1990's, as a result of the Base Realignment and Closure Commissions (BRACC), we combined the Science and Technology pieces of the development process with Test and Evaluation and moved the Naval Air Development Center from Warminster, Pennsylvania, to the Naval Air Test Center in Patuxent River, Maryland. At the same time, another realignment began at the Naval Air Systems Command and the Test Center (now the Naval Air Warfare Center or NAWC.) NAVAIR became known as the Naval Air Systems Team (NAST) and realigned itself into Program Teams. The first platform to fully use this was the E-2C.

The move from Warminster allowed the flying laboratories that developed new systems, and researched new technologies, to be directly integrated with the developmental test community. Often, our test pilots flew these flying laboratories and

could interface directly with the scientists that were working a particular project. The NAVAIR/NAWC reorganization into Program Teams allowed for the development of Integrated Product Teams, each drawing members from throughout the NAVAIR competency matrix into their individual teams, under the cognizance of a Program Manager. Soon, members of the team came from all parts of the aviation community, industry, the program office, and the Research Development, Test, and Evaluation community as well. Test pilots and engineers flying these research projects took information and data back to the program office, influencing the current and future programs that the research would soon touch. They also fed valuable data into the R&D community about fleet needs and desires as these experimental systems continued to develop.

Teaming now occurs on many levels within the overall NAVAIRSYSCOM Team. The program office's each have their own Program Operating Guides, which show the lay down of each of their product teams. Within the test community, teams are created and supported based on the cost, schedule, and performance requirements established by the customer (usually the program office). Rapid prototyping teams are usually very high priority, work over a very short-time period, and encompass a large number of people. In the late 1980's during the Persian Gulf conflicts, the P-3 community was doing littoral surveillance and sea control with their new ISAR radar. At that time, the P-3, normally an open ocean 'blue water ops' aircraft, had few survivability features. Yet, she was operating in the tightly confined waters of the Persian Gulf flying over threats on night reconnaissance missions. With one squadron already on patrol, the next was in work-ups up to relieve them in theatre. A rapid prototype team was established to modify the planes of the next squadron to go. They had the daunting task of developing, installing, and testing four survivability enhancements in test aircraft, then installing these features in five fleet planes within 6 weeks. The team that was established was run entirely by the test community. Test pilots and test engineers, experts on the P-3 platform and the survivability systems being installed, teamed with system's manufactures and industry and were completely supported by the program office. Facilities and capabilities throughout NAST were used to install, test, and retrofit the modifications. Surprisingly, communications with the receiving squadron and training for her crews proved the toughest of the tasks, as the team raced to solve the monumental engineering, design, and installation challenges. The final plane was completed 1 day ahead of schedule and left Patuxent River for the deployed site.

On a large program team, like the P-3 Antisurface Warfare Improvement Program, smaller elite teams form the nucleus for individual tests, while a single project officer manages the overall testing efforts. A flight test team would form up for a weapons test program, for example, that included members from maintenance and range support and services. Flightcrews would include the project officer (usually a test pilot or test NFO) and qualified aircrewmen. Test engineers familiar with the platform would be included, as well as others who are experts on the weapon itself. Depending on the stage of development, the team would travel to the contractor's facility to interface with the developers, as in a new start, or for the integration of an existing weapon, the developers would meet the team at the integration facility. All members of the test team have a "no

vote." The no vote is the individual's ability to stop a flight test program for a limited duration if some piece under their cognizance didn't measure up or was creating confusion. After a "reasonable man" review of the safety or systems issues, the project continues. Project officers stay with the program for 2 to 3 years and work primarily that program, providing stability and continuity to the team.

Where is teaming going in the future? Again, in the large aircraft arena, we are looking at the inclusion of the Naval Research Labs (NRL) flight research detachment into the Force Aircraft Test Squadron. Test pilots and engineers will begin flying with other researchers that were, in the past, isolated within the confines of NRL. Teams of test pilots and engineers are working directly with industry on the Joint Strike Fighter (JSF) program. JSF is the next generation aircraft intended to support the role of fighter and attack aircraft for the Navy and Air Force. Throughout the test communities, test pilot and project officer roles are becoming integrated directly with like people from prime contractors. Test pilots from Grumman fly flight tests in Patuxent River side by side with Navy test pilots assigned to Pax River and vice-versa. Boeing test pilots fly with Navy test pilots in Pax River, trading off sorties in the F/A-18E/F. Navy Joint Primary Aircraft Trainer Systems project officers (test pilots) fly with Air Force and Raytheon test pilots at Beech Wichita.

Is it perfect? No. Is teaming the answer to every programmatic issue? No. While teaming can be an effective means of getting to the heart of a problem and solving it, teaming can create some problems too. Teams must be careful not to make decisions "in committee." These decisions can often be a compromise that is one of expedience rather than consensus, creating less than optimal designs or solutions to existing problems. Team training can be expensive and time consuming. As team members leave and are replaced by new members, this training must usually be repeated by the entire team to fully incorporate that new member. There are still many people who resist change and want complete control over programs. There are still those that see no value in flight test. There are still hard feelings between teams as a result of problems from the past. There are still "old timers" in program offices who view the test pilot and the test community as "those test guys." There are very functional teams and nonfunctional teams. For a team to work properly, all members have to "buy in" to the 'no vote' concept and trust the abilities of the members. All members of the team must understand the constraints the team must operate under, especially financial constraints, and technological limitations and work towards those ends. Most importantly, all members of the team must have the dedication to complete the program or kill the program (whichever is required) based on the needs of the fleet user.

Flight test in Patuxent River is making positive and dramatic moves to incorporate the team concept into all flight test programs. "Up front and early" has replaced "kick it over the fence" as the basic flight test philosophy. In a world where tradeoffs between cost, schedule, and performance drive the entire acquisition process, the team concept is gaining strength. The product continues to be better and better as potential problems are

averted on many programs earlier and earlier. Early problem identification and resolution are saving millions of dollars, and are enabling a much higher mission performance and safer aircraft for the flight test program and the end fleet user.

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